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FOSSIL ENERGY, CO_2, CLIMATE CHANGE, AND THE AEROSOL PROBLEM

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ABSTRACT

Climate change due to increasing atmospheric carbon dioxide differs from stratospheric ozone depletion, regional air pollution, and acid deposition, because emission of CO_2 is intrinsically coupled to production of the energy on which our industrial society relies. Unlike chlorofluorocarbons there are no readily available substitutes, and unlike sulfur or nitrogen oxides and hydrocarbons, CO_2 can be removed from the waste stream only with difficulty and great expense (energy penalty). Consequently, until alternative energy sources are developed or a practical means of sequestering CO_2 is developed, we are faced with continued CO_2 emissions. Determining how much more CO_2 can be emitted into the atmosphere consistent with a given allowable increase in global temperature above preindustrial, e.g., 2˚C, requires knowledge of Earth's climate sensitivity, the increase in global temperature per increase in radiative forcing, which is uncertain by about a factor of 2. The observed increase in temperature over the twentieth century is well less than that which would be expected from radiative forcing by incremental greenhouse gases alone together with the current best estimates of climate sensitivity and planetary energy imbalance. Possible explanations are a lower climate sensitivity and/or partial offset of the greenhouse gas forcing due to cooling forcing by tropospheric aerosols; as aerosols, unlike CO_2, are short-lived in the atmosphere, reduction of emission of aerosols and precursor gases would reveal the committed warming that has been masked by the aerosol cooling forcing. Allowable future CO_2 emissions so as not to commit the planet to a temperature increase of 2˚C above preindustrial are at most a few decades at present emission rates; the possibility that Earth is already committed to such a temperature increase cannot be ruled out. These considerations conspire to make climate change a challenging scientific problem and an enormously difficult societal issue.